Chapter 7: Drainage Water and Its Effect on Wildlife Resources

I. Introduction

A goal of IFDM is to dispose of highly saline agricultural subsurface drainage water in an environmentally sound way that does not impact wildlife. Draft Title 27 Solar Evaporator Regulation states, *"The solar evaporator shall be operated to ensure that avian wildlife is adequately protected."*

Depending on the design and management of the solar evaporator, wildlife, such as shorebirds and waterfowl, may be attracted to the solar evaporator if standing water or scattered puddles are allowed to form. The saline subsurface drainage water may contain elevated selenium, which is the primary constituent of concern, and the hyper-saline water itself may impact wildlife.

II. Laws that Address Wildlife Issues

- California Code of Regulations (CCR) Draft Title 27 Solar Evaporator Regulations established minimum requirements for the design, construction, operation and closure of solar evaporators as components of IFDM systems with the intent of protecting wildlife from exposure to salt and selenium.
- California Environmental Quality Act (CEQA): environmental impact analysis is a component of CEQA, and delineates mitigation and monitoring requirements that may have to be incorporated into an IFDM system in order to ensure adequate CEQA compliance.
- Migratory Bird Treaty Act (MBTA) is enforced by both the USFWS and the CDFG.
- Federal Endangered Species Act (FESA) and the California Endangered Species Act (CESA) were created to protect species from extinction and are enforced by the USFWS and the CDFG, respectively.

See Chapter 9 for more details on laws and regulations.

The Central Valley Regional Water Quality Control Board currently is developing regulations regarding monitoring. The following is from Draft Title 27 Solar Evaporator Regulations, §22940:

Inspection – The CVRWQCB issuing a Notice of Authority to Operate a solar evaporator shall conduct authorized inspections in accord with §25209.15 of Article 9.7 of the Health and Safety Code to ensure continued compliance with the requirements of this article. The CVRWQCB shall request an avian wildlife biologist to assist it in its inspection of each authorized solar evaporator at least once every May. If an avian wildlife biologist is not available, the CVRWQCB shall nevertheless conduct the inspection. During the inspection, observations shall be made for compliance with §22910 (a) and (v), and the following conditions that indicate an unreasonable threat to avian wildlife:

(1) Presence of vegetation within the boundaries of the solar evaporator;

(2) Standing water or other mediums within the solar evaporator that support the growth and dispersal of aquatic or semi-aquatic macro invertebrates or aquatic plants;

(3) Abundant sustained avian presence within the solar evaporator that could result in nesting activity;

(4) An apparent avian die-off or disabling event within the solar evaporator;

(5) Presence of active avian nests with eggs within the boundaries of the solar evaporator.

A qualified wildlife biologist or agent identified by the Central Valley Regional Water Quality Control Board, may conduct the following biological surveys:

- Monitor for aquatic invertebrate activity if standing water is present for greater than 48 hours;
- Monitor bird activity (bird census, year round, monthly to twice per month);
- If nesting is detected, monitor nesting activity and nest fate (every 1-2 weeks from mid-March through July);
- If nesting is detected, collect egg selenium concentration data;

- Collecting and research take permits from the CDFG and USFWS are required for the collection of mammals, birds and their nests and eggs, reptiles, amphibians, fish and invertebrates.
- According to Draft Title 27 Solar Evaporator Regulations, §22940:

If active avian nests with eggs are found within the boundaries of the solar evaporator, the RWQCB shall report the occurrence to the USFWS and DFG within 24 hours, and seek guidance with respect to applicable wildlife laws and implementing regulations. Upon observation of active avian nests with eggs within the boundaries of the solar evaporator, all discharge of agricultural drainage water to the solar evaporator shall cease until (a) the nests are no longer active, or (b) written notification is received by the owner or operator, from the RWQCB, waiving the prohibition of discharge in compliance with all applicable state and federal wildlife laws and implementing regulations (i.e., as per applicable exemptions and allowable take provisions of such laws and implementing regulations.)

III. Constituents of Concern

A. Selenium

Selenium originates from the natural weathering of cretaceous shale (rocks that have the highest selenium concentration 500-28,000 ppb); however, there are two human-related activities that have resulted in the mobilization and introduction of selenium into aquatic systems. The first activity is the irrigation of selenium-containing soils for crop production in arid to semiarid areas of the country. The other source is from the procurement, processing (i.e. oil refineries), and combustion of fossil fuels (Lemly and Smith, 1987).

Selenium is a double-edge sword. Animals needs trace levels of the mineral in their diet for survival, but at levels slightly above trace amounts it can be very toxic. In addition, clinical signs for selenium deficiency are similar to selenium toxicity. Many veterinarians have misdiagnosed selenium toxicity as a selenium deficiency, resulting in adding selenium supplements to a patient's diet, which increased the toxicity response to a higher level.

The signs of acute selenium poisoning in laboratory animals include garlic breath, vomiting, dyspnea (difficulty or shortness of breath), tetanic spasms of the muscles, and respiratory failure (Koller and Exon, 1986). Acute poisoning of livestock is associated with plant material containing 400-800 ppm selenium (Eisler, 1985). "Alkali disease" is a livestock disease resulting from chronic selenium exposure; it is characterized by a lack of vitality, anemia, stiffness of joints, deformed and sloughed hooves, roughened hair coat, and lameness (Koller and Exon, 1986).

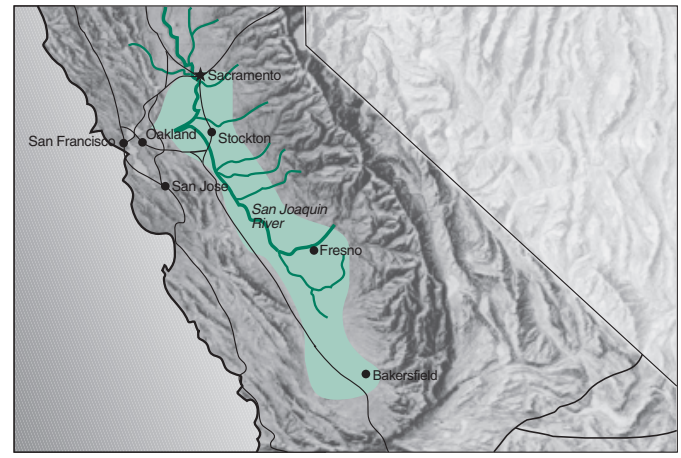

Figure 1. Land area with aquatic systems that maintain various levels of constituents of concern for wildlife.

The most common signs of selenium poisoning in wild birds are emaciated adults, poor reproduction rates, embryonic deaths and deformities (missing or abnormal body parts, such as wings, legs, eyes, and beaks, and fluid accumulation in the skull), and adult mortality (Friend and Franson, 1999). In order to diagnose selenium poisoning, factors such as a history of potential exposure, gross developmental defects, microscopic lesions (evidence of chronic liver damage), and selenium concentrations in tissues, food, water and sediment must be examined.

Plants and invertebrates in contaminated aquatic systems can accumulate selenium, which can sometimes reach levels that are toxic to birds and other organisms that eat them (Friend and Franson, 1999) as shown in Figure 1.

B. Boron

Boron is an essential trace nutrient necessary for plants and animals, as well as for some species of fungi, bacteria and algae. Boron is naturally

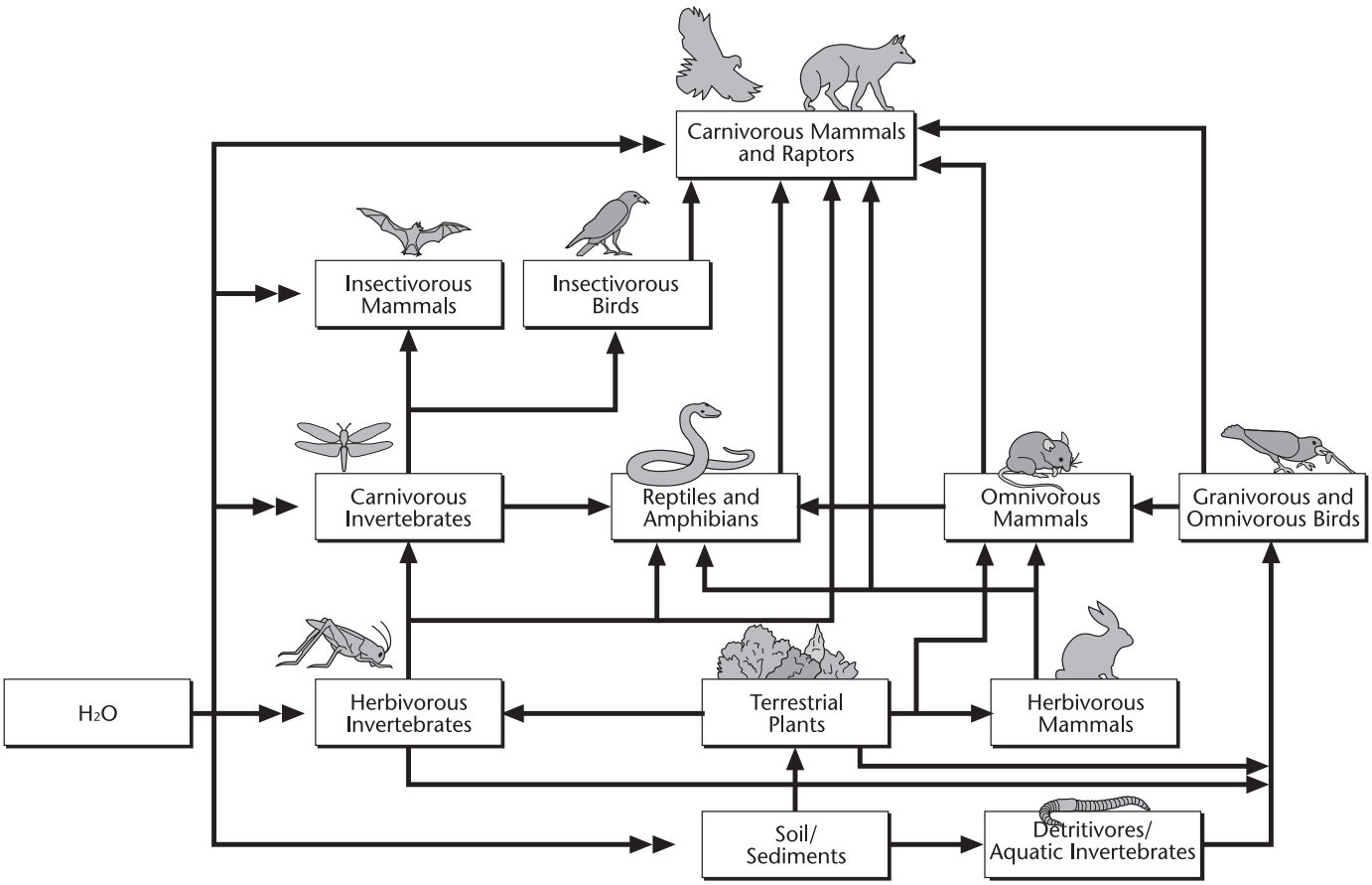

Figure 2. Bio-accumulation of selenium flow-chart for wildlife.

occurring and is found in varying concentrations in San Joaquin Valley soils and water. There is some evidence that elevated boron may decrease the growth rate of chicks. Also different plant species, including agricultural crops, have different tolerances to boron concentrations in soil and water.

C. Molybdenum

Molybdenum is an essential micronutrient. Evaporation ponds in the southern San Joaquin Valley often contain high concentrations of molybdenum (Ohlendorf and Skorupa, 1993). There is little information about the negative effects of molybdenum on avian and mammalian wildlife.

D. Arsenic

Arsenic is a teratogen (causes deformities) and carcinogen (causes cancer), which can cause fetal death and malformation in many mammal species but may be an essential nutrient in small amounts. High levels of arsenic have been found in the water and sediments of some agricultural subsurface drainage evaporation basins, in the soil, and in underground water tables in the San Joaquin Valley. However, to date, elevated concentrations of arsenic have not been found in wild bird eggs. In addition, some aquatic invertebrate species have been negatively affected by arsenic in the evaporation basins (Ohlendorf and Skorupa, 1993).

E. Salinity and Salt Toxicosis

Evaporation basins are used to collect and dispose of highly saline subsurface drainage water produced in the Tulare Basin, and to a limited extent, on the Westside of the San Joaquin Valley. Aquatic invertebrates, such as brine shrimp, thrive in the hyper-saline water and attract many birds. Waterfowl, particularly the ruddy duck, have been affected by salt encrustation of feathers and salt toxicosis by loafing and feeding in deep hyper-saline water evaporation basins. Salt toxicosis

(sodium poisoning) generally occurs in times of drought or cool winter temperatures when there is no access to fresh water. The symptoms of salt toxicosis include conjunctivitis (swelling of the eyelids), lens opacity, cataract formation, and vascular congestion in various organs such as the oropharynx (throat), lungs, kidney, and spleen, and most prominently in the meninges of the brain, and myocardial and skeletal muscle degeneration (Gordus et al., 2002). Gordus et al. (2002) found that ambient temperatures below 4°C and hyper-saline water >70,000 µmhos/cm resulted in salt encrustation and salt toxicosis in ruddy ducks.

IV. Water Quality Objectives

Table 1. Water quality objectives for the protection of wildlife. Please note that the following threshold values may change based on future State and Federal regulatory water quality objective requirements. Note: µg/L equals microgram per liter and mg/L equals milligrams per liter.

	Target Water Quality	Water Quality Needs Further Study	Unacceptable
	No Effect	Level of Concern	Toxicity
Selenium (µg/L)[a]	<2	2-5	>5
Arsenic (µg/L)	<5	5-10	>10[b]
Boron (mg/L)	<0.3	0.3-0.6	>0.6[c]
Molybdenum (µg/L)	<10	10-19	>19[b]

a Draft Environmental Impact Statement (EIS)/Environmental Impact Report (EIR), Grassland Bypass Project, 2001-2009 (URS 2000).

b Preliminary Draft Water Quality Criteria for Refuge Water Supplies Title 34 PL 102-575 Section 3406 (d) 1995. The California Regional Water Quality Board Agriculture Water Quality Objectives for molybdenum is 10 µg/L (A Compilation of Water Quality Goals, Marshack 1998).

c Proposed California Regional Water Quality Board Boron and Salinity Objectives for Full Protection of Beneficial Uses in the Lower San Joaquin River at Vernalis. The California Regional Water Quality Board agriculture water quality objective for boron is 0.70 to 0.75 mg/L (A Compilation of Water Quality Goals, Marshack 1998).

V. Biological Sampling

A. Aquatic Invertebrates

Many studies have shown that aquatic invertebrates (insects, snails, worms, etc.), can accumulate high levels of selenium from water and sediment. Sampling and measuring the selenium concentrations of aquatic invertebrates is one of the best indicators for monitoring predator exposures in cases where information is difficult to obtain directly from predator species (Luoma and Presser, 2000). Sampling of aquatic invertebrates may need to be performed if there is standing water that has elevated selenium concentrations, has an established population of invertebrates, and a significant number of birds are observed feeding and using the flooded area.

B. Bird Eggs

Many cases have shown that aquatic birds that feed and nest at subsurface drainage water disposal sites have above normal rates of embryo mortality and teratogenesis and adult mortality, as seen at Kesterson Reservoir (Ohlendorf & Skorupa, 1989).

Collecting bird eggs is the most efficient method for determining selenium impacts to birds that feed and nest at a solar evaporation basin. This is because bird eggs are easy to find and collect, the loss of one egg collected from a nest is not enough to negatively impact a population, embryos are the most sensitive life stage to selenium poisoning, and egg selenium concentrations represent a direct selenium exposure relationship to the adult female over time (Lemly, 1996).

VI. Maintaining a Bird-Free Solar Evaporator

Factors that make solar evaporators attractive or unattractive to birds are:

- Size of the solar evaporator – Larger solar evaporators are more attractive than smaller solar evaporators.
- Location – Is the site within or near a local flyway corridor or wildlife area or refuge? The Valley historically supported extensive wetlands that provided important stop-over foraging and resting habitat for migratory birds. As a result, any artificial "wetlands" that currently occur within the Valley are very attractive to water birds due to the limited wetland acreage remaining.
- Depth of water – Shallow water attracts shore birds and dabbling ducks, and deep water attracts ruddy ducks and eared grebes.

- Standing water – Aquatic invertebrates can become established, which is a food base for water birds.
- Design and management – Certain designs and management techniques enhance the attractiveness of a pond to birds.

Avoidance measures to greatly reduce the negative impacts on waterbirds were developed by several researchers in cooperation with DFG and USFWS, (San Joaquin Valley Drainage Program, 1999), (Bradford et al. 1991), (CH2M Hill et al. 1993), (Salmon and March, 1991), (California Department of Water Resources and San Joaquin Valley Drainage Program, 1998). These measures include:

- Design – Steep banks, flat or level bottoms, no uneven bottoms or high spots, no windbreaks, islands or internal berms present.
- Management – An effective program may reduce the likelihood of a solar evaporator attracting waterbirds to a site.
  - Hazing (propane cannons and cracker shells) is one avoidance measure that may be effective in reducing migratory birds foraging and nesting in or around the solar evaporator during the early spring and summer months. Note: Shorebirds and dabbling ducks, such as northern shovelers, mallards and pintails, are easier to haze compared to eared grebes and diving ducks, such as ruddy ducks. Hazing should be discontinued after a nest has become established and eggs have been laid so the nest is not abandoned.
- To prevent aquatic invertebrates from becoming established, do not allow water greater than 1 cm in depth to stand for more than 48 hours.
- Keep dikes, banks and pond bottoms weed free. Manual weed control should not take place during the nesting season unless a qualified wildlife biologist has determined the area to be nest free.
- Appropriate monitoring program should be in place that support an Adaptive Management Program.